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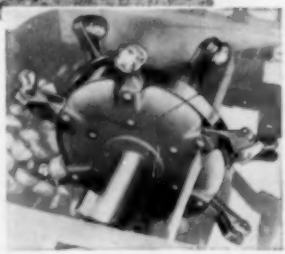

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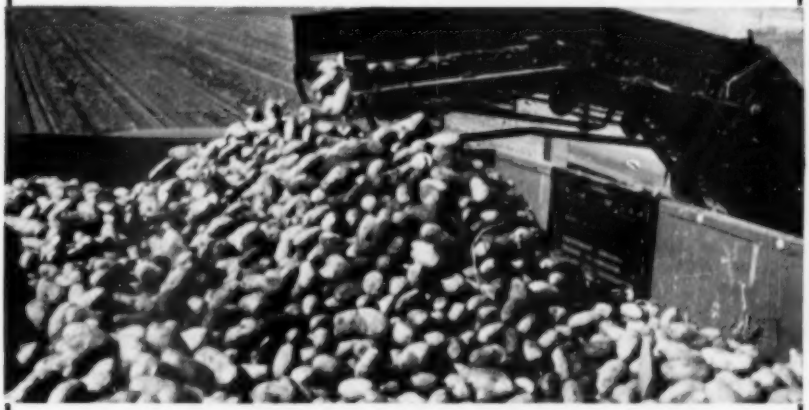

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We welcome the above firms as sustaining members and express to them our appreciation for their interest and financial support.

CONTENTS

NEWS AND REVIEWS

OUR COVER PICTURE—*Eighty-one of those who attended the Sixth National Potato Utilization Conference at Cornell University, Ithaca, N. Y., November 17-19, 1954, are shown in this picture. One hundred and thirty persons attended the sessions of this Conference. They represented research men, processors, growers and handlers of potatoes from 15 states and Canada.* *See page 69.*

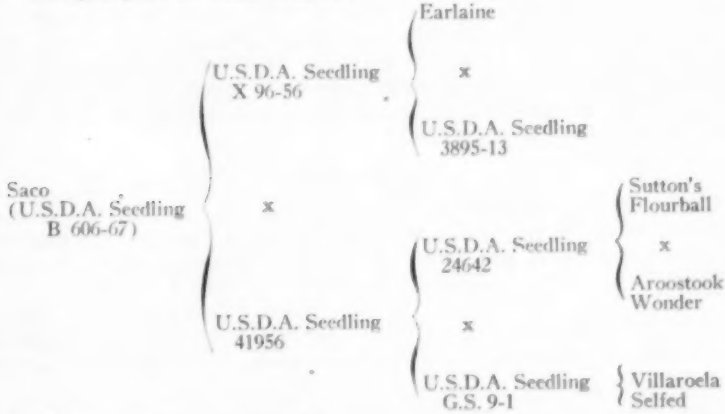
SACO:[1] A NEW LATE-MATURING VARIETY OF POTATO, IMMUNE FROM COMMON RACE OF THE LATE BLIGHT FUNGUS, HIGHLY RESISTANT TO IF NOT IMMUNE FROM NET NECROSIS, AND IMMUNE FROM MILD AND LATENT MOSAICS

R. V. Akeley,[2] F. J. Stevenson,[2] E. S. Schultz,[2] Reiner Bonde,[3] K. F. Nielsen[3], and Arthur Hawkins[4]

The Horticultural Crops Research Branch of the United States Department of Agriculture and the Agricultural Experiment Station of the University of Maine released a new variety of potato named Saco.

The national policy in naming and releasing new potato varieties prepared by a committee of representatives of the United States Department of Agriculture and of directors of State Agricultural experiment stations, and concurred in by the Agricultural Experiment Station of the University of Maine, states as its first requirement: "No new variety should be released unless it is distinctly superior to existing commercial varieties in some one or more characteristics important for the crops and is at least satisfactory in other major requirements." It is believed that Saco meets these conditions. It is equal to Green Mountain, a standard variety in Maine, in yielding ability and dry-matter content. However, Saco is superior to the standard because of its immunity from the common race of the late blight fungus, its high resistance to, if not immunity from, net necrosis, and its immunity from mild and latent mosaics, all of which frequently cause large losses in the Green Mountain variety.

The pedigree of Saco follows:



[1]Accepted for publication July 30, 1954.
Saco, the name of a town in York County, Maine. (In southern Maine, pronounced Sock'-o).

[2]Senior Horticulturist (Presque Isle, Maine), Principal Geneticist (Beltsville, Md.), and Principal Pathoplogist (Beltsville, Md.), respectively, Horticultural Crops Research Branch, Agricultural Research Service ,United States Department of Agriculture, Washington, D. C.

[3]Plant Pathologist and Assistant Agronomist, respectively, Agricultural Experiment Station of the University of Maine, Orono, Maine.

[4]Agronomist, Storrs (Conn.) Agricultural Experiment Station, Storrs, Conn.

Description

PLANTS. Large to medium, spreading. *Stems*: Medium thick, prominently angled. *Nodes*: Slightly swollen, green. *Internodes*: Green. *Wings*: Medium prominent, slightly waved, single green. *Stipules*: Of leaves, medium-sized, green, scantily pubescent to none; of lowest peduncle small, scimitar-shaped, clasping, green, scantily pubescent. *Leaves*: Large to medium, closed, green. *Midribs*: Green, scantily pubescent. *Petioles*: Green, scantily pubescent. *Terminal leaflets*: Large, ovate, acute, lobed, asymmetical. *Primary leaflets*: Large, broadly ovate, four pairs, mean length 53.8 ± 0.7 mm (2.1 inches), mean width 31.3 ± 0.5 mm (1.2 inches), index 58.0 ± 0.4.[5] *Petiolules*: Green. *Secondary leaflets*: Many, between pairs of primary leaflets and junction of midrib and petioles. *Tertiary leaflets*: Many. *Inflorescence*: Much branched. *Leafy bracts*: None. *Peduncles*: Inserted in axils of petioles and main stem, of medium length, green, scantily pubescent. *Pedicles*: Medium to long, green, scantily pubescent. *Cork ring*: Conspicuous, without reddish pigment.

FLOWERS. *Buds*: Green. *Calyx lobes*: Medium-sized (6-8 mm), awl-shaped, not foliaceous, tips straight and green. *Corolla*: Large. (diameter 31-37 mm), white color. *Anthers*: Orange-yellow, pollen abundant and of good quality. *Style*: Slightly twisted. *Stigma*: Globose, multilobed, green.

TUBERS. Short and round, thickness medium and flattening toward the stem end, mean length, 81.5 ± 0.6 mm. (3.2 inches),[6] mean width, 78.0 ± 0.4 mm. (3.1 inches),[6] mean thickness 61.3 ± 0.5 mm. (2.4 inches,[6] indexes, width to length 96.4 ± 1.3,[7] thickness to length 75.7 ± 0.9,[8] thickness to width 78.7 ± 0.4.[8] *Skin*: Smooth, self-colored, dark cream buff or chamois (Ridgway).[9] *Eyes*: Shallow to medium shallow. *Eyebrows*: Medium to long, curved, medium pominent. *Flesh*: White. *Sprouts*: Color when developed in the dark, pale vinaceous lilac (Ridgway).[9] *Maturity*: Late.

Characteristics

Saco is a vigorous high-yielding, late-maturing variety. For 3 years at 4 locations in Maine, it was tested for yield, percentage of solids, and other characters in comparison with Green Mountain, Kennebec, and Katahdin. The data for these tests are given in tables 1, 2, and 3.

The average yields for the 12 tests were 516 bushels per acre for Saco, 495 for Green Mountain, 512 for Kennebec, and 441 for Katahdin. The differences in average total yield between Saco, Green Mountain,

[5]Calculated by dividing the width by the length of each 100 leaflets and multiplying by 100. The leaflets were taken from the fourth leaf from top of the stem, one leaflet, the distal leaf lateral, being taken from each leaf. Since the potato leaflet is asymmetrical, the length was determined by taking the average of the measurements from the apex to the base of each respective lobe.

[6]The average of measurements of 100 tubers, each of a weight of approximately 8 ± 1 ounces.

[7]Calculated by dividing the width of each 100 tubers by the length and multiplying the average of these ratios by 100. The data used for calculating the indexes were taken from the same measurements as those used to designate the dimensions of the tubers.

[8]Based on measurements of the same tubers as those used for determining the width-to-length index, using the same methods of calculations.

[9]Ridgway, R. Color Standards and Color Nomenclature. 43 pp., illus. Washington, D. C., 1912.

TABLE 1.—*Yields and percentage of solids of Saco compared with those of standard varieties grown at 4 locations in Maine, 1951.*

Variety	Dover-Foxcroft		Exeter		Presque Isle		Sherman Mills		Mean All Locations		
	Total Yield[1]	Solids	Total Yield	Solids	Total Yield	Solids	Total Yield	Solids	Total Yield	2- to 4" Size	Solids
	Bus.	Per Cent	Bus.	Per Cent	Bus.	Per Cent	Bus.	Per Cent	Bus.	Bus.	Bus.
Saco	494	18.9	580	19.7	700	20.2	733	19.1	627	556	19.5
Green Mountain	466	19.2	460	20.2	702	22.2	503	19.1	533	423[2]	20.2
Kennebec	466	17.3	628	18.4	707	19.9	698	18.4	625	543	18.5
Katahdin	468	17.7	373	17.3	638	19.7	477	16.9	489	422[2]	17.9
L.S.D. at .05	76	.73	90	.96	58	.96	85	.47	38	42	.40

[1]Low yield at Dover-Foxcraft due chiefly to verticillium wilt.
[2]Green Mountain and Katahdin potatoes not graded at Exeter and Sherman Mills because of late blight tuber rot; the yields of 2- to 4-inch size for these 2 varieties grown at those 2 locations were estimated.

TABLE 2.—*Yields and percentage of solids of Saco compared with those of standard varieties grown at 4 locations in Maine, 1952.*

Variety	Pittsfield		Exeter		Presque Isle		Sherman Mills		Mean All Locations	
	Total Yield	Solids	Total Yield	Solids	Total Yield	Solids	Total Yield	Solids	Total Yield	Solids
	Bus.	Per Cent	Bus.	Per Cent	Bus.	Per Cent	Bus.	Per Cent	Bus.	Per Cent
Saco	342	17.1	505	17.3	466	21.7	331	20.2	411	19.1
Green Mountain	316	15.7	605	17.6	460	21.7	414	19.7	449	18.7
Kennebec	258	14.2	546	15.7	404	19.9	392	18.2	400	17.0
Katahdin	206	14.2	530	16.7	391	19.7	277	17.7	351	17.1

TABLE 3.—*Yields and percentage of solids of Saco compared with those of standard varieties grown at 4 locations in Maine, 1953.*

Variety	Houlton		Exeter		Presque Isle		Madawaska		Mean All Locations		
	Total Yield	Solids	Total Yield	Solids	Total Yield	Solids	Total Yield	Solids	Total Yield	Over 2"	Solids
	Bus.	Per Cent	Bus.	Per Cent	Bus.	Per Cent	Bus.	Per Cent	Bus.	Bus.	Per Cent
Saco	515	23.2	437	19.2	437	21.7	652	19.7	510	492	21.0
Green Mountain	564	21.0	341	17.4	520	21.6	581	19.7	502	481	19.9
Kennebec	566	21.2	372	19.4	540	20.2	568	18.4	512	497	19.8
Katahdin	579	19.7	319	18.2	486	20.5	548	17.9	483	464	19.1
L.S.D. at .05	61	1.1	78	1.4	68	1.1	68	1.4	34		.62

and Kennebec were not great, but Saco outyielded Katahdin by 75 bushels per acre.

The percentage solids, as usual, varied from place to place and from season to season, but on the average Saco was among the varieties high in dry-matter content. The averages of the 12 tests were 19.8 per cent solids for Saco, 19.6 for Green Mountain, 18.4 for Kennebec, and 18.0 for Katahdin.

The tubers of Saco are somewhat irregular in shape but predominantly short and round and slightly flattened toward the stem end. The skin is smooth, dark cream-buff — white in the language of the trade. The eyes are shallow to medium shallow. The flesh is white.

In certain tests in Maine, and in other States, Saco has shown a tendency to produce off-type tubers, but this characteristic is usually offset by its high yielding ability, with the result that after grading out the poorly shaped potatoes, the net yield of marketable tubers is often higher than that produced by standard varieties. The best evidence of this is found in the results of 3-year tests of 4 varieties at 2 locations in Connecticut (tables 4, 5, and 6).

The overall means for percentage of primes for the 6 tests in Connecticut showed Katahdin ranking first with 93.1 per cent primes; Kennebec second, with 88.4; Saco third, with 81.9; and Green Mountain fourth, with 80.9 per cent. The mean yields in bushels of primes per acre placed the four varieties in a different order. Saco ranked first with 684 bushels of primes per acre; Kennebec second, with 606; Katahdin third, with 577; and Green Mountain, fourth with 520. These data show that it would be profitable to grow Saco for table stock even if a relatively large percentage of tubers must be culled out. Despite the high percentage of pickouts Saco outyielded Kennebec, Katahdin, and Green Mountain in the production of primes. It might be noted also that the percentage of culls in Green Mountain was slightly higher than in Saco.

Saco has excellent potential value for processing. The dry-matter content of its tubers for each of the 3 years it was grown on the Aroostook Farm, Presque Isle, Maine, was high enough to make it suitable for french frying or chipping, and it should be very suitable for the production of starch or alcohol. The tubers in the tests at Presque Isle in 1951 produced 20.2 per cent solids; in 1952, 21.7; and in 1953, 21.7 per cent (Tables 1, 2, and 3). In each test the percentage was higher than the 19.7 per cent generally accepted as indicating potatoes suitable for french frying or chipping.

Saco accumulates reducing sugars at a slow rate when stored at 40° F. and responds quickly to reconditioning at higher temperatures. The results of storage and cooking tests in Maine in the fall and winter of 1953-1954 indicated that the tubers of Saco may not require reconditioning if stored at 45°. Tubers of this variety were held at a storage temperature of 45° for about four months; other tubers of Saco after storage for approximately 3 months at 45° were placed in 60° storage and held at the latter temperature for 5-, 11-, 18-, and 25-day periods. French fries and chips were equally as good in color, texture, and flavor when made from tubers held the full storage period at 45° as were those from tubers changed to a temperature of 60° for reconditioning for 5-, 11-, 18-, and 25-day periods.

TABLE 4.—*Total yields and yields of primes*[1] *of Saco, as compared with those of 3 standard varieties, at 2 locations in Connecticut, 1951.*

Variety	Yield per Acre							
	Ellington			Wapping			Mean Yield	
	Total	Primes	Primes	Total	Primes	Primes		
	Bus.	Bus.	Per Cent	Bus.	Bus.	Per Cent	Bus.	Per Cent
Saco	715	573	80.1	995	817	82.1	695	81.1
Green Mountain	619	503	81.3	775	717	92.5	610	86.9
Kennebec	528	455	86.2	744	689	92.6	572	89.4
Katahdin	595	553	92.9	615	573	93.2	563	93.0

[1]Primes = Potatoes 1⅞ inches or over in size after rough tubers were culled out.

TABLE 5.—*Total yields and yields of primes*[1] *of Saco, as compared with those of 3 standard varieties, at 2 locations in Connecticut, 1952.*

Variety	Yield per Acre							
	Windsorville			Ellington			Mean Yield	
	Total	Primes	Primes	Total	Primes	Primes		
	Bus.	Bus.	Per Cent	Bus.	Bus.	Per Cent	Bus.	Per Cent
Saco	1,062	891	83.9	784	560	71.4	726	77.7
Green Mountain	701	497	70.9	601	445	74.0	471	72.5
Kennebec	983	859	87.4	552	457	82.8	658	85.1
Katahdin	605	569	93.9	621	576	92.8	573	93.4

[1]Primes = Potatoes 1⅞ inches or over in size after rough tubers were culled out.

TABLE 6.—*Total yields and yields of primes*[1] *of Saco, as compared with 3 standard varieties, at 2 locations in Connecticut, 1953.*

Variety	Yield per Acre							
	Somers			Enfield			Mean Yield	
	Total	Primes	Primes	Total	Primes	Primes		
	Bus.	Bus.	Per Cent	Bus.	Bus.	Per Cent	Bus.	Per Cent
Saco	889	799	89.9	555	465	83.8	632	86.9
Green Mountain	738	688	93.2	365	268	73.4	478	83.3
Kennebec	803	780	97.1	472	397	84.1	589	90.6
Katahdin	716	705	98.5	558	487	87.3	596	92.9

[1]Primes = Potatoes 1⅞ inches or over in size after rough tubers were culled out.

Saco is susceptible to wilt *Verticillium* sp. but it compares favorably with standard varieties in yield and dry-matter content when grown in soil infested with the wilt fungus. In 1951 the yields from the test plots at Dover-Foxcraft, Maine, were low due chiefly to wilt Verticillium sp, but Saco yielded 494 bushels per acre compared with 466 for Green

Mountain and Kennebec and 468 for Katahdin. Green Mountain was first in dry-matter content with 19.2 per cent, Saco second, with 18.9 per cent; Katahdin third, with 17.7 per cent, and Kennebec fourth, with 17.3 (Table 1).

In 1952 and 1953 Saco was grown in comparison with a number of other varieties in wilt-infested soil on the Ashby Farm, Caribou, Maine. Data for wilt, yield, and percentage of solids of Saco, Green Mountain, Kennebec, and Katahdin are given in table 7. The standard error for wilt was not calculated for the 1952 tests, but in 1953 there were so significant differences in wilt infection among the 4 varieties. Furthermore, there were no significant differences in yield in either of the 2 years, but the dry-matter content of Saco was significantly higher than that of any of the other varieties.

Saco is highly resistant to if not immune from 4 major diseases to all of which Green Mountain is susceptible. It is immune from the common race of the late blight fungus, highly resistant to if not immune from net necrosis; and also immune from mild and latent mosaics.

TABLE 7.—*Reaction to wilt (Verticillium sp) as reflected in yields and dry-matter content of 4 varieties of potato grown in wilt-infested soil on the Ashby Farm, Caribou, Maine, 1952 and 1953.*

Variety	Wilt			Yield U.S. No. 1 Tubers per Acre			Solids		
	1952	1953	Mean	1952	1953	Mean	1952	1953	Mean
	Per cent	Per cent	Per cent	Bus.	Bus.	Bus.	Per cent	Per cent	Per cent
Saco	74	63	69	502	440	471	20.4	20.3	20.4
Green Mountain	67	44	56	519	451	485	19.4	18.5	19.0
Kennebec	82	54	68	448	412	430	17.0	18.4	17.7
Katahdin	48	42	45	469	415	442	18.0	18.0	18.0
L.S.D. at .05		23		76	55	46	.10	.07	.06

DISCUSSION

Saco is late maturing, requiring for the best results about the length of growing season as Green Mountain. For this reason it ought to be planted as early in the spring as possible so that maximum yields and maximum percentages of dry matter may be produced before killing frosts occur.

Saco is immune from the common race of the late blight fungus. The value of blight resistance was clearly demonstrated in a year like 1951 when weather conditions prevented the application of fungicides at the proper time, and large losses occurred among the susceptible varieties. In that year epidemics of late blight occurred in the test plots at Exeter and Sherman Mills, Maine, and the two resistant varieties Saco and Kennebec outyielded the susceptible varieties Green Mountain and Katahdin by wide margins. At Exeter, Saco yielded 120 bushels per acre more than Green Mountain and 207 bushels more than Katahdin. At Sherman Mills, Saco yielded 230 bushels per acre more than Green Mountain and

256 bushels more than Katahdin. The yields of marketable potatoes of the two susceptible varieties were further decreased by late blight tuber rot. Because of the rot the yields of potatoes of Green Mountain and Katahdin from 2 to 4 inches in size could not be determined by weight. They had to be estimated (Table 1).

The years 1952 and 1953 were not bad blight years and no such reductions in yield resulted in the experimental plots (Tables 2 and 3).

Net necrosis caused by current-season infection with the leaf roll virus is one of the reasons why so many growers in Maine in recent years have been producing immune varieties such as Katahdin and Chippewa and have discontinued the production of the susceptible variety Green Mountain. Saco is highly resistant to if not immune from net necrosis, and since it usually outyields Katahdin and, when grown properly, is higher in dry-matter content it should replace this variety to some extent, especially for processing purposes.

Field immunity from mild mosaic (caused by virus A + virus X) is not as important as it was formerly. This character is found in Katahdin and Kennebec, and the disease is kept to a minimum in the very susceptible variety Green Mountain by growing the crop in an isolated place and by roguing and early harvesting. Saco shows an immune reaction to virus A in the field and in some tests in which it was artificially inoculated with this virus it showed a hypersensitive reaction resulting in virtual immunity.

Latent mosaic virus (virus X) is carried in many potato varieties, such as Green Mountain, Kennebec, and Katahdin, without producing conspicuous symptoms. It is spread by contact and in many varieties is is practically impossible to detect latent mosaic plants in the field. Consequently, virus X is more widely harbored in most of the old and some of the new varieties than any of the other potato viruses. Notwithstanding the general latent mosaic infection in such varieties, they are healthy by commercial standards, but the stocks are diseased by scientific criteria.

Despite the fact that virus X produces no visible symptoms in some varieties the importance of latent mosaic in reducing yields has become more and more evident not only in the United States but also in other countries. Bald and Norris (1) found that in Australia latent mosaic in President and Up-to-Date varieties reduced the yield about 30 per cent and that it is one of the chief causes of the reduction in yield of potatoes in that country, but, because its effects are evenly spread over almost the entire crop, latent mosaic passes unnoticed. Scott (3) reported that in Scotland latent mosaic (virus X) was responsible for yield reductions of 16 to 25 per cent. Schultz and Bonde (2) showed results from comparative yield tests which indicated that latent mosaic was responsible for 9 to 22 per cent reduction in yield, and since this mosaic is generally harbored by most of the old potato varieties and some of the new ones it is evident that latent mosaic when occurring alone is responsible in this country for annual losses in yield of millions of bushels. Furthermore, because virus X in combination with other viruses affects the yield more adversely than when alone, additional yield losses of millions of bushels result from virus X in such mixed infections.

Because of the heavy toll taken annually by latent mosaic, programs

have been undertaken in the United States and in other countries to produce foundation seed stock free from the causal virus. Such programs are costly and can never be too satisfactory since as soon as the virus-free or nearly virus-free seed is distributed to growers it is almost certain to come in contact with other potatoes carrying latent mosaic virus, and since the disease is spread by contact the efforts and expense put forth to produce the disease-free seed are soon annulled. The best solution to the problem is the use of immune varieties.

Saco is immune in the field and in graft tests from latent mosaic and will eliminate the losses from this disease wherever the variety is grown. There are a number of strains of the latent mosaic virus but Saco apparently is immune from all of them. It is the first variety released in the United States immune from latent mosaic.

Years of cooperative work were required by plant breeders and plant pathologists to combine in one variety high yield, high dry-matter content, immunity from the common race of the late blight fungus, resistance to, if not immunity from, net necrosis, immunity from mild mosaic, and also from latent mosaic. In the course of this work many other seedling varieties with multiple resistance have been produced but Saco is the best one of the group that has been tested extensively for yield, dry-matter content, and other horticultural characters. Because of its high yielding ability and multiple resistance to disease, it should be one of the cheapest varieties to grow that has yet been produced, and because of its ability to produce tubers with a high dry-matter content it should be satisfactory for table use or processing.

Summary

Saco (U.S.D.A. B 606-67) is a late-maturing high-yielding variety. The tubers of Saco are predominantly short and round with a tendency to produce off-types. After grading out the poorly shaped potatoes the net yield of marketable tubers is often higher than that produced by standard varieties. Saco, as grown in Maine, produces tubers as high in dry matter as the best standard varieties. Its tubers accumulate reducing sugars at a low rate at 40° F. High-quality chips and french fries were made from them without reconditioning after about 4 months in storage at 45° F.

Saco is susceptible to verticillium wilt but yields comparatively high in soil infested with the causal fungus. It is immune from the common race of the late blight fungus, highly resistant to if not immune from net necrosis, immune from mild mosaic, and immune from latent mosaic. It is the first variety released in the United States immune from latent mosaic. Its high-yielding ability and disease resistance should make it one of the cheapest varieties to grow, and its high dry matter content should make is satisfactory for table use or processing.

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SEEDLINGS OF *SOLANUM TUBEROSUM* L. AS INDICATOR PLANTS FOR POTATO LEAFROLL VIRUS[1]

KARL MARAMOROSCH[2]

In 1948 Kirkpatrick (3) demonstrated that *Physalis floridana, P. angulata,* and *Datura stramonium* could be used as test plants for potato leafroll virus and that all three species developed symptoms within 15 to 30 days following inoculation. He indicated that an ideal plant for transmission studies with this virus should develop distinct and unmistakable symptoms in a short time after inoculation even by a single insect, that it should be usable in the early seedling stage, be grown from true seed, and also be a favorable food source for the insect vector.

In the hands of the writer the three indicator plants fell short of the suggested ideal. Signs of leafroll in each of them were often uncertain because of the effect of environmental conditions. The length of time necessary for detection of disease was comparatively long (30 days). Chlorotic areas in *Datura* were sometimes caused by fumigation and simulated leafroll symptoms. *Physalis* plants were occasionally stunted even when not infected. In searching for a more convenient and dependable indicator plant, seedlings of various species were tested. However, none was found that came closer to the ideal postulated by Kirkpatrick than potato seedlings of the Earlaine variety. Dr. F. J. Stevenson, Principal Geneticist in charge of potato breeding at the United States Department of Agriculture, Beltsville, Maryland, kindly supplied seed from self-fertilized Earlaine potatoes. Leafroll-infected material was grown from tubers of the U.S.D.A. variety No. 41956, obtained from Dr. E. S. Schultz. This variety is immune from virus X. The infected tubers were harvested August 30, 1953, from leafroll propagation plots at Presque Isle, Maine, and planted in a greenhouse in New York in December, 1953. Peach aphids *Myzus persicae,* used as vectors in inoculations, were obtained from stock reared by Dr. R .H. E. Bradley at the Field Crop Insect Laboratory, Frederickton, New Brunswick, Canada, and selected there for high efficiency in leafroll virus transmission.

Potato seeds were sown in a 6-inch pot in a mixture of sand and soil. Individual plants were transplanted to 4-inch or 2-inch pots at the 4 to 5-leaf stage. When the seedlings were approximately 3 inches in height they were inoculated by means of infective aphids. A virus-free aphid colony was maintained on turnip or Chinese cabbage plants. Viruliferous aphids were obtained by caging stock insects on leafroll-diseased potatoes for 10 days. Infective vectors were confined to the young potato seedlings in screened celluloid cages for one week.

The first signs of leafroll disease were noticed in potato seedlings as early as four days after inoculation. They consisted of rolled leaves and stunting which became more pronounced with time. Figure 1 shows tops of a diseased and a healthy seedling two weeks after that at the left was exposed to infected aphids and at the right to virus-free aphids. It was concluded that potato seedlings of the variety Earlaine were excellent indicator plants in which to observe the effects of potato leafroll

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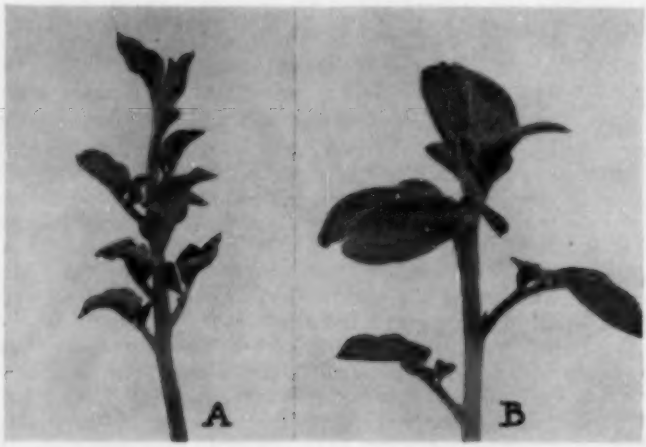

FIGURE 1.—A, Leafroll-infected *S. tuberosum* seedling showing marked rolling of leaves, and stunting 2 weeks after inoculation. B, Non-infected, —control plant of same age. (*Photograph by J. A. Carlile.*)

virus. Seedlings of this and other potato varieties have been used in virus experiments by several investigators (1, 2).

SUMMARY

Potato seedlings grown from seed of *S. tuberosum* L., var. Earlaine, were tested as indicator plants for potato leafroll virus. Signs of potato leafroll disease appeared as early as four days after inoculation and consisted of rolled leaves, followed by stunting. For this reason, potato seedlings of the Earlaine variety appear to be excellent indicator plants for the leafroll virus.

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FURTHER INVESTIGATIONS ON THE USE OF MALEIC HYDRAZIDE AS A SPROUT INHIBITOR FOR POTATOES[1]

S. N. RAO[2] AND S. H. WITTWER[3]

The effectiveness of maleic hydrazide as an inhibitor of storage sprouting in potatoes was first suggested by Zukel (9). Subsequently, Wittwer and Paterson (8), Paterson, *et al.* (6), Marshall and Smith (3, 4) and Denisen (1) have reported that sprouting may be retarded by maleic hydrazide.

For control of sprouting, penetration of the chemical into the tuber appears essential (5). Although post-harvest applications have not been found feasible, preharvest foliar sprays are highly effective. Considerable variation in response to maleic hydrazide when it is applied at different stages in the development of the potato vine has been reported (1, 3, 4,) and differences among varieties of potatoes and other crops noted (2, 4, 7,). The response of several potato varieties to maleic hydrazide applied at different stages during plant development is herein reported.

EXPERIMENTAL—1953

Methods:

Seed pieces of certified stock of Triumph, Irish Cobbler, Chippewa and Sebago varieties were planted April 29 on a Hillsdale sandy loam soil in rows 36 inches apart with seed pieces at 12-inch intervals. Standard commercial procedures were followed in crop fertilization and insect and disease control.

As outlined in table 1, a single aqueous spray of 2500 parts per million (ppm) of MH[4] was applied to the foliage of twice replicated plots of the four varieties June 4, June 18, July 1, July 15 and August 4. Approximately 7 pounds of MH-40 (2.8 pounds of actual maleic hydrazide) were applied per acre. A split plot design was employed with varieties as main plots and spray treatments as subplots. Each plot consisted of two parallel 18-foot rows.

Harvesting was completed and total yields recorded September 17. Following harvest the potatoes were held in common storage (temperature range of 38 to 80° F.) for 25 days to allow suberization of the tubers injured during harvest.They were then placed as 20-tuber samples in a storage with the temperature thermostatically controlled at 55° F. until April 2, 1953, at which time the average weight of sprouts per tuber was determined.

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[4]Formulated as the water soluble sodium salt of 1,2-dihydro 3,6-pyridazinedione and supplied as MH-40 by the U.S. Rubber Company, Naugatuck Division, Naugatuck, Conn.

TABLE 1.—*Effect of preharvest foliar sprays of maleic hydrazide on the yields and storage quality of potato varieties. 1952-1953*

	Total Yield (Bus./Acre)	Marketable Yield (Bus./Acre)	Tubers Deformed Per cent	Sprout Growth (Gms./ Tuber)
Variety				
Irish Cobbler	491	336	26.1	5.79
Chippewa	489	382	7.8	6.28
Triumph	423	288	21.5	18.58
Sebago	347	297	3.4	5.81
Least differences 5 Per cent	49	No significance	13.0	1.68
Necessary for significance 1 Per cent			23.8	3.09
Maleic Hydrazide (2500 Ppm)				
Dates of Application				
June 4 (Plants 3 to 6 inches high)	483	326	20.1	17.05
June 18 (Pre-bloom)	296	114	51.1	12.45
July 1 (Bloom)	415	366	4.1	2.49
July 15 (Bloom)	407	346	5.5	0.41
August 4 (Post-bloom)	460	414	1.2	0.36
Control (No chemical treatment)	560	447	7.3	21.94
Least differences 5 Per cent	54	59	14.3	4.39
Necessary for significance 1 Per cent	74	81	19.5	6.38

Results:

The data in table 1 show that all applications of maleic hydrazide reduced total yields. Marketable yields were not, however, reduced by the August 4 application. In particular, the June 18 treatment reduced both total and marketable yields with over 50 per cent of the tubers deformed. Significant reductions in storage sprouting occurred with all treatments. In treatments associated with the least storage sprouting (July 1, 18 and August 4), the percentages of deformed tubers were less and the percentages of the total yield that were marketable were somewhat greater than in the controls. Significant differences in the yielding abilities, percentages of deformed tubers, and storage sprouting among varieties were noted.

Differences in varietal response to treatment are illustrated in figure 1 for Triumph and Chippewa. Whereas the July 15 and August 4 applica-

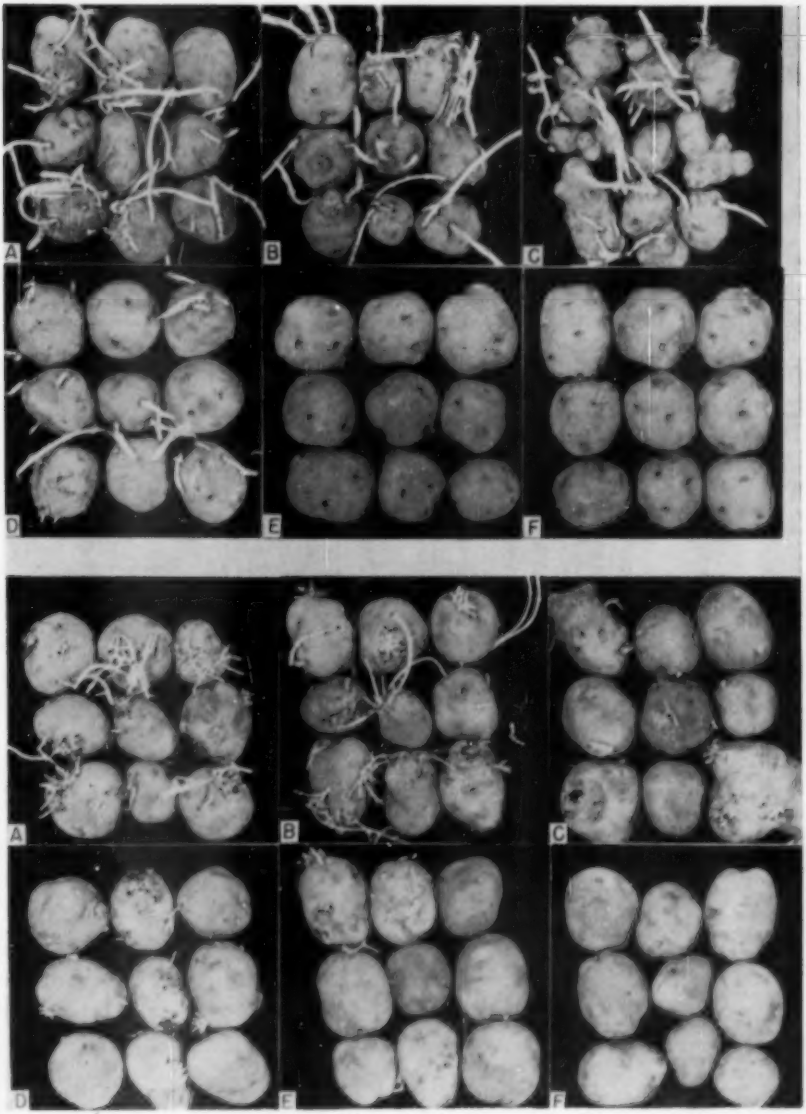

FIGURE 1.—The effect of time of application of MH and variety on sprouting and tuber abnormalities. A—Controls; B—June 4; C—June 18; D—July 1; E—July 15; and F—August 4. Top, Triumph; Bottom, Chippewa.

tions effectively controlled sprouting in both, the Triumph tubers were badly deformed by the June 18 treatment with no effect on Chippewa. With respect to per cent of tubers deformed, Chippewa was similar to Sebago, and Irish Cobbler to Triumph. The greater sprouting tendency of the controls and early treatments was apparent in Triumph, but late applications of MH were equally as effective in controlling sprouting as in Chippewa.

Experimental—1954

Methods:

Seed pieces of Green Mountain, Kennebec, Russet Rural, Triumph, Pontiac, Chippewa, Russet Burbank, Sebago, Irish Cobbler, and Katahdin were planted on May 15.

As outlined in table 2, a single aqueous spray of 2500 ppm of MH (equivalent to 7 pounds of MH-40 per acre) was applied to the foliage of all ten varieties on the dates indicated. Varieties and treatments were

Table 2.—*Effect of time of application of maleic hydrazide on yield of U. S. No. 1 potatoes—September, 1953*

Treatment	Green Mountain	Kennebec	Russet Rural	Triumph	Pontiac	Chippewa	Russet Burbank	Sebago	Irish Cobbler	Katahdin	Treatment Averages
Maleic Hydrazide (2500 Ppm)	U. S. NO. 1 POTATOES (BUSHELS PER ACRE)										
Dates of Application											
June 15 (Plants 3 to 6 inches high)	104	239	239	40	169	209	134	266	87	204	169
June 29 (Pre-bloom)	331	291	127	35	244	493	104	244	157	204	223
July 13 (Bloom)	709	458	448	331	430	610	348	284	371	378	437
July 31 (Bloom)	674	453	476	423	622	622	488	388	430	493	507
August 13 (Post-bloom)	819	615	702	598	737	692	575	622	570	540	647
August 25 (Post-bloom)	814	645	592	570	592	650	517	754	510	510	615
Control (No chemical treatment)	802	697	685	674	657	605	605	540	458	396	612
Variety Averages	608	485	467	382	493	554	396	443	369	389	

Least differences necessary for significance between:

	5 Per cent	1 Per cent
Varieties	87	120
Treatments	56	73
Treatments x Varieties	167	225

randomized in a split plot design with three replications. The varieties constituted the main plots, with treatments the subplots Twelve plants at one-foot intervals comprised each plot.

Following harvesting on September 24, the total yields, yield of U. S. No.1 tubers, percentage of deformed tubers, and the average tuber size were recorded. After holding in common storage for 3 weeks, random 15 pound samples of each plot were transferred to a storage where the temperature was maintained at 45° F. for 12 weeks and at 60° F. for the succeeding 10 weeks. On February 10 and again on March 24, the sprouts were removed and weighed, and the total weight of sprouts as per cent of original tuber weight determined.

Results:

The yields of U. S. No. 1 potatoes in bushels per acre for each variety as influenced by the time of treatment are given in table 2. Significant reduction in yield occurred with all varieties from the June 15 and June 29 applications. These two treatments also resulted in a high percentage of deformed tubers (Table 3), a considerable reduction

TABLE 3.—*The effect of time of application of maleic hydrazide on the production of deformed potatoes—September, 1953.*

Treatment	Green Mountain	Kennebec	Russet Rural	Triumph	Pontiac	Chippewa	Russet Burbank	Sebago	Irish Cobbler	Katahdin	Treatment Averages
Maleic Hydrazide (2500 Ppm) DEFORMED POTATOES (PER CENT OF TOTAL YIELD)											
Dates of Application											
June 15 (Plants 3 to 6 inches high	50	32	19	66	42	23	55	0	62	8	36
June 29 (Pre-bloom)	27	33	50	75	33	14	48	14	45	30	37
July 13 (Bloom)	8	6	2	14	11	0	23	10	12	5	9
July 31 (Bloom)	2	17	1	13	10	0	13	0	16	0	7
August 13 (Post-bloom)	1	19	6	2	2	8	12	4	5	2	6
August 25 (Post-bloom)	3	4	7	7	6	0	18	0	10	0	6
Control	3	6	8	10	5	0	8	2	7	0	5
Variety Averages	13	17	13	27	16	6	25	4	22	6	

Least differences necessary for significance between:

	5 Per cent	1 Per cent
Varieties	11	14
Treatments	9	12

TABLE 4.—*Effect of time of application of maleic hyrazide on tuber size—September, 1953.*

Treatment	Green Mountain	Kennebec	Russet Rural	Triumph	Pontiac	Chippewa	Russet Burbank	Sebago	Irish Cobbler	Katahdin	Averages Treatment
Maleic Hydrazide (2500 Ppm)											
Dates of Application	AVERAGE WEIGHT IN POUNDS PER TUBER										
June 15 (Plants 3 to 6 inches high)	0.18	0.26	0.20	0.19	0.30	0.25	0.19	0.29	0.22	0.21	0.23
June 29 (Pre-bloom)	0.20	0.28	0.15	0.13	0.27	0.26	0.12	0.30	0.19	0.17	0.21
July 13 (Bloom)..	0.27	0.32	0.19	0.19	0.27	0.33	0.24	0.21	0.28	0.29	0.26
July 31 (Bloom)..	0.38	0.38	0.27	0.41	0.45	0.38	0.37	0.45	0.36	0.41	0.39
August 13 (Post-bloom) ..	0.37	0.38	0.32	0.45	0.48	0.34	0.35	0.38	0.34	0.42	0.38
August 25 (Post-bloom) ..	0.46	0.43	0.28	0.40	0.43	0.35	0.36	0.43	0.31	0.52	0.40
Control	0.42	0.42	0.30	0.41	0.48	0.38	0.35	0.36	0.35	0.44	0.39
Variety Averages	0.33	0.35	0.24	0.31	0.38	0.33	0.28	0.35	0.29	0.35	

Least differences necessary for significance between:

	5 Per cent	1 Per cent
Varieties	0.09	0.12
Treatments	0.03	0.04

in tuber size (Table 4), with no material reduction in storage sprouting (Table 5).

Differences in varietal response to treatment are significant. Only in Chippewa were the yields not reduced by the July 13 application (or any treatment thereafter). Marked reductions in yields were noted for Green Mountain, Kennebec, Russet Rural, Triumph, Russet Burbank, and Sebago from the July 31 treatment, with no significant yield decreases for Pontiac, Chippewa, Irish Cobbler or Katahdin. No significant yield reductions in any variety resulted when MH was applied August 13 or 25.

It may be noted (Tables 3 and 4) that marked differences among varieties occurred with respect to the effects of the earlier MH treatments (June 15 and 29) on the percentages of deformed tubers and average size of tubers. With Triumph, Russet Burbank and Irish Cobbler more than 50 per cent of the tubers were deformed, with little influence noted for Chippewa, Sebago or Katahdin. No significant tuber deformation occurred with the July 13 treatment or any thereafter. Tuber size was

TABLE 5.—*Effect of preharvest foliar sprays of maleic hydrazide on storage sprouting of potato varieties—March 24, 1954.*

Treatment	Green Mountain	Kennebec	Russet Rural	Triumph	Pontiac	Chippewa	Russet Burbank	Sebago	Irish Cobbler	Katahdin	Treatment Averages
Maleic Hydrazide (2500 Ppm)											
WEIGHT OF SPROUTS AS PER CENT OF ORIGINAL WEIGHT											
Dates of Application											
June 15 (Plants 3 to 6 inches high)	4.8	2.8	2.0	7.3	5.5	4.6	2.3	2.4	4.2	2.6	3.9
June 29 (Pre-bloom)	2.5	1.6	2.0	8.2	3.9	2.5	1.4	2.3	1.5	2.2	2.8
July 13 (Bloom)	.8	.3	.5	.3	.9	.6	.1	2.0	.3	.3	.6
July 31 (Bloom)	.3	.1	.1	.1	.5	.3	.4	1.2	.4	.1	.4
August 13 (Post-bloom)	1.1	1.4	.4	.5	.9	.7	.3	.5	.8	.8	.7
August 25 (Post-bloom)	1.2	1.3	1.3	1.2	1.5	1.6	.3	2.5	2.5	.4	1.4
Control	7.9	2.5	2.0	4.7	5.1	3.4	3.1	3.3	3.7	2.8	3.9
Variety Averages	2.7	1.4	1.2	3.2	2.6	2.0	1.1	2.0	1.9	1.3	

Least differences necessary for significance between:

	5 Per cent	1 Per cent
Varieties	0.2	0.3
Treatments	0.1	0.7
Treatments x Varieties	0.9	1.7

significantly reduced by the June 15, 29, and July 13 applications in all varieties. Most significant decreases in size occurred with Green Mountain Russet Rural, Triumph, Russet Burbank, Irish Cobbler and Katahdin. The June 15 and 28 applications resulted in the production of large numbers of small tubers in the above-named six varieties. Sprouting in the tubers harvested from plants sprayed June 15 and 28 was comparable to and, in some instances, greater than the controls (Table 5).

Storage sprouting (Table 5) was effectively reduced in all varieties except Sebago when MH was applied either July 13 or 31, and the August 13 treatment gave good control with the possible exception of Kennebec. Of the varieties tested, Kennebec and possibly Green Mountain were the only ones in which storage sprouting was not effectively controlled without reductions in yield. Excellent control of sprouting resulted from the July 31 application with Pontiac, Chippewa, Irish Cobbler and Katahdin. This was associated with no reduction in yield, tuber size or significant increase in deformed tubers. For Russet Rural, Triumph,

Russet Burbank and Sebago, the August 13 application gave good control of sprouting and no reductions in yield. The data in tables 2, 3, 4, and 5 suggest that Pontiac, Chippewa, Irish Cobbler, Katahdin, and possibly Russet Burbank are varieties in which MH may be effectively applied over a considerable period of time. On the other hand, timing of applications is more critical with Green Mountain, Kennebec, Russet Rural, Triumph, and Sebago if effective control of storage sprouting is to be achieved without yield reductions and tuber abnormalities.

Summary and Conclusions

The effectiveness of preharvest foliar sprays of maleic hydrazide (MH) in retardation of storage sprouting in potatoes without accompanying yield reductions and deformed tubers is dependent upon time of application with respect to the stage of plant development and influenced greatly by variety.

Of the four varieties tested in 1952-1953, Irish Cobbler and Triumph tubers were severely deformed by treatments of 7 pounds per acre of MH-40 applied shortly following plant emergence and during pre-bloom. Little injury was noted on Chippewa and Sebago. Bloom and post-bloom applications significantly reduced storage sprouting. The post-bloom application (August 4) very effectively controlled sprouting on all varieties with a reduction in total but not marketable yield.

In 1953-1954, ten potato varieties were planted May 15 and similarly sprayed following plant emergence with MH at approximately two-week intervals. With all varieties, the two earliest applications (June 15 and 29) resulted in significant reductions in yield accompanied by a high percentage of deformed tubers, a significant reduction in tuber size, and no practical reduction in storage sprouting. Application of MH on July 31 effectively controlled sprouting without yield reductions on Pontiac, Chippewa, Irish Cobbler and Katahdin, whereas the August 13 application was found most satisfactory for Russet Rural, Triumph, Russet Burbank, and Sebago. Pontiac, Chippewa, Irish Cobbler, Katahdin and possibly Russet Burbank responded favorably to treatments of MH over a considerable period of time, while timing of MH applications for effective control of sprouting without yield reductions and other adverse influences was more critical with Green Mountain, Kennebec, Russet Rural, Triumph and Sebago.

It is concluded that MH may be successfully used as a preharvest spray for the retardation of storage sprouting in potatoes if applied to the green foliage 1 to 2 weeks after bloom and approximately 6 weeks prior to the anticipated harvest. Therefore, May plantings harvested in late September might appropriately be treated August 10 to 15.

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SOME VARIATIONS IN SYMPTOMATOLOGY AND TRANSMISSION OF LEAFROLL IN POTATO[1]

R. E. Webb, E. S. Schultz, and R. V. Akeley[2]

Introduction

At Presque Isle, Maine, some plants of potato seedling X927-3, which had not become infected with the leaf roll virus after 12 years of continuous field exposure, developed apical dwarfing and some leaf pigmentation during 1952. These symptoms closely resembled the initial symptoms of purple-top wilt (1). Plants from virus-free tubers of seedling X927-3 that were grafted with cores from leaf-roll-infected tubers of Katahdin developed similar symptoms. When healthy plants were enclosed in cages into which leaf-roll-virus-infective green peach aphids, *Myzus persicae* (Sulz.) were introduced, they reacted similarly.

Tubers from plants showing atypical symptoms in 1952 were harvested and planted in 1953. For comparative studies, several healthy tubers of seedling X927-3 were grafted with cores from leaf-roll-infected Katahdin tubers, and healthy plants also were colonized with leaf-roll-infective aphids in insect-proof cages.

Plant emergence from tubers infected the previous season was very irregular and growth was atypical. Approximately 80 per cent of the infected seed pieces produced multiple, weak, spindling sprouts which did not emerge before late July and made little growth after emergence (Figure 1D). These spindling-sprout plants were dwarfed and erect but showed severe leaf rolling. Chlorosis and pigmentation developed in the affected leaves. About 12 to 13 per cent of the seed pieces produced plants moderately to severely dwarfed, erect, bushy, and chlorotic but without leaf rolling. Growth was initiated in many of the axillary buds (Figure 1C). Toward the end of the season some of the lower leaves developed slight to moderate roll. The remaining plants showed typical second-generation symptoms of leaf roll. These plants were moderately dwarfed, erect, bushy, and chlorotic and there was uniform distribution of leaf rolling over the entire plant (Figure 1A). Plants from healthy tubers of seedling X927-3 which had been grafted with cores from leaf-roll-infected Katahdin tubers developed apical symptoms similar to those induced by some of the viruses causing "yellows" (1, 3). Healthy plants exposed to leaf-roll-infective aphids produced similar symptoms. Apical stems, leaves, and petioles were severely dwarfed, but leaf rolling was absent (Figure 1C). Mild to moderate leaf chlorosis developed immediately after the onset of dwarfing of apical parts. Late in the season affected plants produced many axillary shoots making the plant stiff, erect, bushy, apically dwarfed, chlorotic, with or without slight basal leaf rolling.

Initial attempts to transmit the leaf roll virus with aphids from seedling X927-3 plants showing the 3 symptom types to 5 young plants

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Illustrations prepared by G.V.C. Houghland and Otis Greeson.

FIGURE 1.—A, Katahdin plant showing typical symptoms of infection by the leaf roll virus. B, Healthy plants of seedling X927-3. C, Current-season leaf-roll-infected plant of seedling X927-3. D, Spindling-sprout plants of seedling X927-3.

of Katahdin, Sebago, Green Mountain, Irish Cobbler, Houma and seedling 41956 potatoes were unsuccessful. In similar transmission experiments in which leaf-roll-infected plants of Katahdin were used as the virus source there was an average of 78 per cent transmission. Only 1 of 7 healthy Bonny Best tomato scions grafted to diseased seedling X927-3 plants developed symptoms of leaf roll. These symptoms, consisting of petiole and leaf epinasty and slight rolling of basal leaflets, did not appear until 42 days after grafting. Aphid transmission of the virus from the diseased tomato scions to an indicator plant was not attempted.

These tests indicated that plants of potato seedling X927-3 were susceptible to the leaf roll virus. However, no effort had been made to reproduce the virus symptom types in healthy seedling X927-3 plants by using diseased plants of seedling X927-3 as a virus source. Experiments were initiated to effect aphid transmission of the leaf roll virus from diseased plants of seedling X927-3 and to study the relation of the virus to the 3 symptom types shown by plants exposed to natural infection by the leaf roll virus. A preliminary report has been presented (8).

Materials and Methods

Tubers of diseased plants of seedling X927-3 showing the "yellows" type and typical leaf roll symptoms were harvested for greenhouse studies. Spindling-sprout plants were transplanted to 6-inch pots and later transported to Beltsville for aphid-transmission studies. Individual tubers (isolates) of 50 Katahdin plants infected with the leaf roll virus which had been used as the virus source in the exposure trials were harvested to determine the strain or strains of the leaf roll virus present.

Graft-transmission studies were attempted by the tuber-core-graft and plant-inarch methods described by Bonde and Schultz (1). Scions from healthy plants were kept in small vials of water until graft unions had been completed. Stocks and scions were held together with clothes pins.

Green peach aphids* *(Myzus persicae)* were used for transmission studies of the virus. Colonies of virus-free aphids were maintained on young broccoli plants in insect-proof cages. *Physalis floridana* Rybd. was used as an indicator host for the leaf roll virus (2).

Results

Graft-Transmission Studies. The relation of the leaf roll virus to the typical and atypical symptoms produced by plants of seedling X927-3 exposed to infection with it in the field had been suggested only by grafting to a tomato plant. Grafts were made with cores from diseased tubers of seedling X927-3 to 5 healthy tubers each of seedling X927-3, Katahdin and seedling 41956 potatoes. Reciprocal grafts were made to healthy tubers of this variety and seedlings with cores from leaf-roll-virus-infected tubers of Katahdin. Symptoms of leaf roll developed 28-37 days after grafting in plants from tubers which had been grafted to cores from virus-infected tubers of Katahdin. Typical leaf rolling developed

*Original colony supplied by Floyd Smith, Agricultural Research Center, Beltsville, Md.

in plants of Katahdin and seedling 41956. Apical dwarfing and some leaf chlorosis developed in 3 of 5 inoculated plants of seedling X927-3. These atypical symptoms appeared 4 to 6 days later than those developing in plants of Katahdin and seedling 41956. Also, diseased plants of seedling X927-3 produced many axillary shoots, and slight basal leaf rolling developed about 62 days after the initial symptom appeared.

Plants from tubers which had been grafted with cores from diseased tubers of seedling X927-3 did not show symptoms of infection until 46-62 days after grafting. Slight to moderate basal leaf rolling developed in all plants of Katahdin and Seedling 41956. Subsequent symptom development was slow, and only ⅓ to ½ of the leaves showed evidence of rolling and cupping 91 days after grafting. Stunting of plants of these varieties was slight to moderate. Plants from core-grafted tubers of seedling X927-3 developed slight to moderate apical stunting without leaf rolling. Secondary symptoms developed fairly rapidly, and the plants were moderately dwarfed, erect, stiff, bushy, and chlorotic. Slight to moderate leaf rolling developed in the lower leaves 20-25 days after appearance of initial symptoms.

Inarch-grafts were made between diseased plants of seedling X927-3 and 5 healthy plants each of Katahdin, seedling 41956 and seedling X927-3. Inarch-grafts were made to similar plants with Katahdin plants as the source of the virus. Essentially the same results were obtained with the inarch-graft method as with the tuber-core graft method. Symptom appearance and development were delayed when diseased seedling X927-3 plants were used as the virus source.

Aphid transmission of the leaf roll virus from the diseased plants in the graft tests to *P. floridana* plants established the presence of the virus. The virus was not recovered with aphids from current-season infected plants of seedling X927-3 until 42 days after the initial symptoms had appeared.

Aphid-Transmission Studies. Spindling-sprout plants produced by 3 seedpieces of seedling X927-3 were colonized with virus-free aphids for 3 days. Since earlier attempts to recover the leaf roll virus from diseased plants of seedling X927-3 with aphids had failed, 15 aphids were transferred from plants of each seed piece to each of 5 *P. floridana* plants in the second-leaf stage. A similar number of virus-free aphids were placed on each of 5 *P. floridana* plants which served as controls. Pliofilm cages perforated for ventilation were used to confine the aphids to the individual test plants. The aphids were allowed to feed for 3 days and then killed with an insecticide.

Twelve to 14 days after inoculation, 3 of the 15 inoculated *P. floridana* plants developed mild petiole epinasty and slight leaf chlorosis. Definite though slight, stunting was noted in affected plants 16 days after inoculation. Affected plants recovered from the initial shock of infection shortly thereafter and subsequent growth was almost equal to that of the controls. Mild to moderate leaf chlorosis continued to be the most evident symptom of virus infection. The control plant and 12 of the inoculated ones remained healthy. Repeated attempts to transfer the leaf roll virus from the spindling-sprout plants to *P. floridana* plants gave similar percentages of transmissions. The infected *P. floridana* plants developed mild symptoms and grew almost as rapidly as the controls.

Tubers from seedling X927-3 plants which had shown typical and atypical leaf roll symptoms the previous season produced plants that developed similar atypical symptoms. Initially these plants showed slight to moderate apical stunting. Subsequently, leaf enlargement was retarded, petioles were erect, axillary bud growth was initiated and small dwarfed shoots developed, leaves became chlorotic, and purplish-red pigmentation appeared in some leaves. Some plants developed slight to moderate rolling of the lower leaves.

Repeated transmissions of the causal virus from the diseased plants of seedling X927-3 to *P. floridana* and healthy plants of seedling X927-3 proved that it was the leaf roll virus. The virus from plants produced from tubers whose parent plants had shown the typical or the atypical symptoms the previous season produced identical symptoms of leaf roll in *P. floridana* plants. This response was very similar to that of *P. floridana* plants infected with the virus from the spindling-sprout plants. Comparative symptomatological studies showed the initial reaction and subsequent symptom development in infected *P. floridana* plants to be identical when infected with the virus from either the spindling-sprout plants or those showing atypical leaf roll symptoms.

Transmission of the leaf roll virus from all spindling-sprout plants of seedling X927-3 was effected eventually but some attempts were not successful. Only 57 per cent of the plants produced from tubers whose parent plants showed either typical or atypical leaf roll symptoms were shown to contain the leaf roll virus. Some attempts to transmit the virus from the infected plants to *P. floridana* plants were not successful. During December, January and February the overall percentage of successful transmissions from spindling-sprout plants and those showing the "yellow" type symptoms was 39.0 per cent. With the advent of warmer temperatures during March, 50.5 per cent of the attempted transmissions were successful; and during April, transmissions of the virus from the diseased plants of seedling X927-3 were almost as successful as those from leaf-roll-infected plants of Katahdin.

Leaf Roll Virus Strains in Infected Plants of Seedling X927-3 and Katahdin Potatoes. Plants of the 50 Katahdin leaf-roll-virus-infected tubers were evaluated for the presence of virus strains. The relative symptomatological effect of the leaf roll virus on plants of *P. floridana* and the immunological relationships between strains were used as criteria for strain differentiation (7). By this technique strain 1 (mild), strain 2 (moderate), and strain 3 (severe) were isolated. The prevalence of the strains in the various tubers (isolates) was about equal. Occasionally more than one strain was isolated from the same plant.

Cooperative studies of virus strains 1, 2 and 3 and the isolates from diseased plants of seedling X927-3 indicated that the isolate consistently recovered from the infected plants of seedling X927-3 was similar to the mild strain 1 in its effect on *P. floridana* plants. Preliminary studies, however, indicated that strain 1 and the X927-3 isolate differed in transmissibility and rate of movement in certain hosts even though they incited a similar microscopic effect on *P. floridana* plants.

Discussion

Just why plants of seedling X927-3 which had been exposed to infection with the leaf roll virus for a 12-year period suddenly contracted it under natural conditions has not been ascertained. Studies indicated that 3 strains of the virus were present in the infected plants of Katahdin which served as the inoculum source to which the seedling X927-3 plants had been exposed. *P. floridana* plants infected with the virus from the diseased seedling X927-3 plants indicated this isolate to be very similar to leaf roll virus strain 1 (mild). The evaluation of the inoculum source plants showed that strain 1 was just as prevalent in the plants as strains 2 and 3. Preliminary studies of the seedling X927-3 isolate of the virus and the 3 known strains indicated certain differences in the ability of aphids to transmit as readily the X927-3 isolate as the three known leaf roll strains. It is apparent that the X927-3 isolate systemically invades the entire plant of certain hosts more slowly than the known virus strain.

The variations in symptomatology of leaf roll in plants of seedling X927-3 were shown to be due at least partially to infection with the virus. The hot dry weather which prevailed during the past two seasons could have been a factor contributing to the large number of seedpieces producing spindling-sprout plants. Schultz and Folsom (6) suggested a possible relation between tuber net necrosis induced by the leaf roll virus and the subsequent production of spindling-sprout plants. However, tuber net necrosis caused by this virus has not been observed in tubers produced by diseased plants of seedling X927-3 and apparently it was not a contributing factor in the production of spindling-sprout plants during 1953.

Infected plants of seedling X927-3 reacted severely to leaf roll virus. The severe apical dwarfing and subsequent symptomatology of leaf roll in this host apparently differ materially from the various, but similar, reactions described by others (5, 6). Initial symptoms of leaf roll are for the most part transitory in most varieties, but varieties in which symptoms are persistent show apical leaf chlorosis, some pigmentation and rolling. In current season infection of plants of seedling X927-3, induced by graft or aphid transmission, severe apical dwarfing and leaf chlorosis are the initial symptoms and these symptoms persist throughout the growing season. Growth of affected plants is greatly retarded, and axillary buds develop and make varying amounts of growth before apical dwarfing sets in. Leaf chlorosis develops slowly on the more mature lower leaves. Late current-season symptoms may include slight to moderate basal leaf rolling. Branch-trace necrosis (4) did not develop in infected plants of seedling X927-3, but was abundant in leaf-roll-infected plants of Katahdin. Except for spindling-sprout plants, second-generation symptoms in affected plants of seedling X927-3 are similar to those induced by current-season infection but they appear earlier. The plants are smaller and show more severe leaf chlorosis than current-season infected plants of the same age.

Grafting experiments indicate that the virus moves slowly through the tissues of diseased X927-3 plants. The typical leaf roll symptoms exhibited by some diseased plants of seedling X927-3 under field conditions could have been partially accentuated by the physiological stress imposed on the plants by the prevailing hot dry weather.

These results strongly suggest leaf roll virus strain specificity in

Solanum tuberosum L. Studies are in progress to test this hypothesis and also to determine further the relation between the X927-3 isolate and strain 1 of the leaf roll virus.

Summary

Plants of potato seedling X927-3 that had been exposed to natural infection with the leaf roll virus over a 12-year period before becoming diseased were found to be infected with it. Initial symptoms of leaf roll in plants of X927-3 were persistent and resembled initial infection of potato plants with some "yellows" viruses. The second-generation symptom types expressed by diseased plants were shown to be induced, in part, by the leaf roll virus. All virus isolations from diseased plants of seedling X927-3 induced a response in *P. floridana* similar to that caused by the mild strain 1. Evaluation of the stock source of the leaf roll virus maintained in Katahdin showed 3 virus strains to be present in the inoculum material. Comparative studies of the X927-3 isolate with the known strains indicated that the X927-3 isolate and the mild strain 1 caused similar reactions in *P. floridana* plants; however, the X927-3 isolate was not as easily transmitted by aphids or by grafting, and it did not become systemic as rapidly in certain hosts as did the remaining 3 virus strains.

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A METHOD OF REARING POTATO-INFESTING APHIDS THROUGHOUT THE YEAR IN THE GREENHOUSE[1]

M. E. MacGillivray[2]

At the Fredericton, New Brunswick, laboratory, continuous investigations on potato-infesting aphids as vectors of virus diseases have been limited to *Myzus persicae* (Sulz.). This species reproduces parthenogenetically on most greenhouse plants throughout the year, and has been readily available. In this locality it has been difficult to maintain continuous cultures of the other important vector species, *Aulacorthum solani* (Kalt.), *Macrosiphum solanifolii* (Ashm.), and *Aphis abbreviata* Patch. Under usual greenhouse conditions at Fredericton, these species cease producing parthenogenetic forms in October and produce sexuales exclusively. Shull (2) showed that temperature and light affected gamic and parthenogenetic reproduction in *M. solanifolii*. Bonnemaison (1) demonstrated that temperature and light affected the mode of reproduction in *M. persicae* and some non-potato-infesting species.

Recent investigations at the Fredericton laboratory have shown that all four potato-infesting species, *M. solanifolii*, *A. abbreviata*, *A. solani*, and *M. persicae*, can now be reared parthenogenetically throughout the year in this area.

In June, 1952, parthenogenetic females of *A. abbreviata*, *A. solani*, and *M. solanifolii* were collected out-of-doors at Fredericton. *A. abbreviata* was collected from *Rhamnus cathartica* L. and the other two species from *Capsella bursa-pastoris* (L.) Medic. The aphids were caged in the greenhouse on excised potato leaves placed in water. Throughout the summer of 1952 the three species were exposed to natural light and greenhouse temperatures.

In September, when greenhouse temperatures fluctuated between 60° and 90° F. and daylight lasted approximately 12 hours per day, it was observed that *A. abbreviata* was producing some male forms, along with viviparous females. As nymphs, the male forms are detected easily by their blue-black color that contrasts with the yellow-green of the viviparous females. When *A. abbreviata* began to produce male forms, the minimum temperature was raised to 75° F. and a fluorescent light of 120 watts was placed 3 feet above the greenhouse bench to extend the photoperiod to 16 hours. Meanwhile, some aphids of each species retained under a low temperature and natural photoperiod produced only sexuales. Under the adjusted conditions, *A. abbreviata* and *M. solanifolii* reproduced parthenogenetically throughout the winter months. However, the culture of *A. solani* was lost because only males and oviparous females were present when the photoperiod was extended and the temperature raised.

In June, 1953, *A. solani* was collected from *C. bursa-pastoris* and transferred to the greenhouse. This species, along with *M. solanifolii* and *A. abbreviata*, was reared on potato throughout the summer. In early

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September, when the first male forms of *A. abbreviata* were produced, the minimum temperature of the greenhouse chamber was raised to 75° F. and the photoperiod extended to 16 hours. All three species continued to produce parthenogenetic females.

M. solanifolii and *A. abbreviata* have been cultured also on intact potato plants since December, 1952, and *A. solani* since June, 1953. When the plants became heavily infested, fresh plants were supplied. During October and November, when potato plants are scarce, the four potato-infesting species will maintain themselves on zinnia. The house plant cineraria is also an acceptable host for *M. persicae*, *A. solani*, and *M. solanifolii* but not for *A. abbreviata*.

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NEWS AND REVIEWS

UTILIZATION OF THE 1954 POTATO CROP[1]

A. E. MERCKER[2]

It is with pleasure that I shall again review the utilization of several recent potato crops and discuss the prospective utilization of the 1954 crop. No longer are potatoes merely boiled and served, or mashed, or baked in the fireplace. Methods have changed. Today, they are baked in well-regulated ranges with controlled temperatures, sometimes with their own covers, sometimes with added covers of aluminum foil or other material. The ready-to-use forms of processed potatoes are many and various and their use is expanding.

The 1953 potato crop of approximately 374 million bushels was of excellent quality. But production exceeded consumption requirements, as estimated by the United States Department of Agriculture, by nearly 15 million bushels. Since potato consumption is very inelastic, the heavy 1953 early crop supplies carried over into the summer, fall and winter and held late crop prices at record low levels, in relation to purchasing power indices, for a large part of the marketing season. This situation resulted in increases in the quantity wasted or fed to livestock and in shrinkage, from 6 per cent of the 1952 crop to 8.4 per cent of the 1953 crop. This compares with approximately 10 per cent loss for the 1940 crop.

One-sixth of the loss in the 1953 crop was due to abandonment of nearly 5½ million bushels of early potatoes that were not worth packaging. The notable advances in storage handling, due to research results applied to commercial storing, brought a marked reduction in potato waste.

CROP SHRINKAGE HIGHER IN 1954

The 1954 crop was grown under difficult conditions and shrinkage is estimated to be somewhat higher than that for the 1953 crop. Based on the November 10 crop report, the 1954 United States average yield, (251.2 bushels), is the second highest on record. Heat, drought, insect pests, disease, and excessive rainfall were offset by the realistic application of recently developed research discoveries.

Now how will this crop be utilized?

Seed sales remain at stable levels. Any increase will depend upon increased acreage or exports. The use of seed has declined because the acreage has declined even though more seed is used per acre. A larger proportion of the seed export business may be obtained through continuous well directed sales and service efforts on the part of the industry. Competition for such business is very keen. The quality must be good to meet expectations of planters.

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Promote Seed Sales

In order to stimulate sales to producers in other lands it may be necessary to consider making a colored sound movie in foreign languages to assist certified seed potato producers in selling the seed. First, it is necessary to register certified seed specifications and programs of the respective States with the Minister of Agriculture of the country in question. If a movie is made, it should emphasize the seed certifying program, including all its available facilities and functions. It should point out the meticulous care with which area producers select potatoes used in their foundation and certified seed programs and should highlight the details of cultural practices employed to produce the crop as well as methods of storing and marketing. To make sales in Latin America, United States producers may need to develop some method of financing sales in addition to collecting the proceeds. All these factors will take considerable time and work.

Increase in Exports

Exports of table stock potatoes will probably increase, particularly to Canada where the 1953 crop of approximately 67 million bushels of potatoes was followed by a 1954 crop of nearly 50.5 million bushels, with sharp decreases in central and eastern Canada. United States exports to Canada in May and June were below those of the preceding year but exports during the remaining summer months were considerably larger. To date exports to Latin America have been somewhat below those of last year. In all likelihood, a total of 7 or 8 million bushels may be exported this season, including off-shore shipments to our insular possessions. This compares with 5.6 million bushels exported last season.

Salvage uses probably will be less this season than they were last, when about 16½ million bushels of potatoes were diverted to starch. Sales of the starch produced last year found such ready outlets that the inventory of potato starch at present is low and that on hand is marked for customers. In all likelihood, not more than about 8 million bushels will be processed into starch from the 1954 crop. Use of potatoes for flour is expected to equal last year's figure of one million bushels.

Increase in Processed Potatoes

The use of dehydrated potatoes in processing meat and vegetable combinations is still increasing. About 12 million pounds were used for civilian purposes from the 1953 crop and it is likely that 15 million pounds may be processed from the 1954 crop. The outlet for quickly reconstituted potatoes for home and institutional use is still developing slowly. The product has so improved in quality that a substantial increase in demand may be expected in the future.

The use of canned potatoes has shown a further increase and in many consumer markets a wider variety of brands is given sales display. The number of processors canning potatoes has increased during the last several years.

Simultaneously frozen French fried potatoes and raw potatoes partially processed or blanched and then frozen are having a larger sale. Sales are increasing and in 1954 it may be that 3,800,000 bushels will be so used, an

increase of approximately 10 per cent over the quantity used from the previous crop. About 29 million bushels were used for potato chips from the 1953 crop and indications point to a use of not less than 31 million bushels from the 1954 crop, which is about equivalent to the quantity of seed potatoes used.

The production of certified seed potatoes, which is greater than the quantity used for seed, amounted to nearly 44.6 million bushels in 1953 as compared with the 1942-1951 average of roughly 38.6 million bushels. From 30 to 33 million bushels of seed are needed annually and some of that seed used is not certified.

I want to call particular attention to the total quantities used by these two outlets and then compare the amount of research work, effort, and funds expended to produce and continually improve certified seed. When we compare the resources and expenditures by individuals, including growers, shippers and State and Federal government officials, to aid in the production and sale of potatoes for chipping purposes or of all processed potatoes, it is small compared to the effort, time, material, and funds spent in improving production and sale of certified seed.

Restaurants Prefer High Quality

The amount of potatoes used by restaurants and institutions is estimated at 64 million bushels from the 1954 crop, compared with 63 million bushels for the preceding crop. For the most part, this outlet desires quality potatoes. The work done by the restaurant industry to demonstrate that quality potatoes are economical and profitable has developed a substantial use of potatoes by this industry. The restaurant industry has pointed out the need of potatoes that are high in specific gravity for baking and for use as French fries. It has led the way in emphasizing that well graded, properly sized potatoes are the most economical to use and the best for their customers. The prepeeled and partially prepared potato industries, including par-fried, sell almost their entire production of 3.5 million bushels to institutional users and hospitals.

During the past three years the quantity of potatoes used fresh in homes has ranged from approximately 160 to 180 million bushels. The drastic decline in consumption of potatoes is almost directly in this field. The 1953 *per capita* consumption was estimated at 104.5 pounds per person. When the quantity that was used in processed form is deducted, about 90 pounds per person were used in fresh form. Had it not been for the use of potatoes in processed form, the bottom would have dropped out of the *per capita* consumption of potatoes. It is in this field that major efforts of the potato producing industry should be focused, if further *per capita* consumption declines are to be averted. Since consumers are not aware of the wholesomeness of potatoes as a food, a long-term program is going to be required to educate them.

Per Capita Consumption Trend Reversed

As I stated last year, it is my firm conviction that the downward trend in *per capita* consumption is reversed and that from now on the increased use of potatoes in processed forms will tend to stabilize the total consumption trend. Our population is increasing and is expected to

TABLE 1.—*United States production and use of potatoes.*[2]

CROP YEAR	1940	1951	1952	1953[4]	1954
Line			— 1,000 BUSHELS —		
(1) Production	376,920	320,519	349,098	373,700	355,099[5]
(2) Imports	930	2,309	3,283	2,924	2,000[1]
(3) Total Supply (lines 1 & 2)	377,850	322,828	352,381	376,624	357,099
(4) Exports	2,495	6,707	4,366	4,603	6,000[1]
(5) Shipments to territories	1,788	1,074	1,033	1,000	1,000[1]
(6) Total Off-Shore Sales	4,283	7,781	5,399	5,603	7,000[1]
(7) Available for Domestic Use Line 3 minus Line 6	373,567	315,047	346,982	371,021	350,099
(8) Used for Seed	41,985	31,096	34,698	31,279	31,300
(9) Fed to livestock, Shrinkage loss	37,238	18,604	20,943	31,354	29,099
(10) Starch	8,030	4,701	8,264	16,500	8,000[1]
(11) Alcohol	.....	.....	.....	.....	.....
(12) Total Non-Food Use Total, lines 8, 9, 10 and 11	87,253	54,401	63,905	79,138	68,399
(13) Total Food Use; line 7 minus 12	186,314	260,646	283,077	291,888	268,700
(14) United States Military Use — Fresh	.....	9,867	7,877	7,700	.....[3]
(15) Estimated Civilian Use; Line 13 minus 14	286,314	250,779	275,200	284,188	268,700
PROCESSED[1]					
16 Flour	400	500	400[1]	1,000	1,000
17 Dehydration	.....	2,620	1,220	3,400	3,000
18 Canning	.....	1,000	1,430	1,550	1,600
19 Hash—Stews—Soups	500	1,200	1,000	1,000	800
20 Frozen French Fried	.....	2,000	2,750	3,500	3,800
21 Potato Chips	4,500	22,760	25,250	29,000	31,000
22 Total Processed; lines 16 to 21[1]	5,400	30,080	32,050	39,450	41,200
23 Sold to Restaurants[1]	40,000	59,000	60,000	63,000	64,000
24 Total; lines 22 and 23[1]	45,400	89,080	92,050	102,450	105,200
(25) Total Used Fresh in Homes Line 15 minus 24	240,914	161,699	183,150	181,748	163,500
(26) Used on Farms Where Produced	63,099	23,541	20,523	18,729	18,500
(27) Purchased Fresh for Home Use; line 25 minus 26	177,815	138,158	162,627	163,019	155,000

[1]Industry estimates and forecasts.
[2]Source, Bureau Agricultural Economics except as noted.
[3]Not available.
[4]Preliminary.
[5]Dec. 17, 1954 Crop Report.

reach 189 million in 1965. If the present rate of *per capita* consumption can be maintained, about 3¾ additional million bushels a year would be consumed — therefore, a crop of nearly 41 million bushels above present levels would be needed by 1965. The potential for increasing the production of potatoes is very large since there is still considerable good land available on which producers could increase plantings to meet a future increased demand. It takes only 10,000 acres to meet a one-pound increase in consumption. It is this tremendous potential for increasing production and the growers' desire to respond quickly to increasing production when prices are favorable that tends to bring about the fluctuations in total production.

Use Production Guides

United States average yields per acre have tended to remain within reasonably narrow limits. Potato producers and members of the allied industries would do well to pay more attention to the production guides and other economic information developed by the United States Department of Agriculture and State agricultural colleges. The adoption of balanced farm rotation practices and the early diversion of surpluses, especially in small sizes and low grades, to livestock food or industrial uses, are mechanisms that the industry can employ to avoid extremely low prices provided it is alert to the adoption of sound marketing programs.

The machinery, including the use of marketing agreements, is available as is also the basic knowledge in the form of outlook information. Further study, however, is necessary so that the industry can learn to time carefully the use of the available implements to solve its problems. The use of all of these mechanisms will help to avoid low-price seasons and increase producer incomes.

THE PRESENT STATE OF POTATO BREEDING IN THE NETHERLANDS

An explanation of present-day work in the field of potato breeding cannot be understood without a short historical introduction, since only as a result of all the work done before the war has the postwar development been possible.

The aim of breeding is to produce new and—in any aspect whatever—better potato-varieties. For that purpose it was usual to cross different varieties of potatoes with each other and to select the best ones among the hybrids. Experience has taught that such seedlings are so variable that among many thousands no two identical plants occur.

From his seedlings the breeder discards 90 per cent, displaying unfavorable properties such as long stolons, badly shaped tuber, deep eyes, *etc*. From each plant kept, five tubers are planted on the following year. In that year he can observe quite a few properties from these 5 plants and he is able to make a positive selection from this material for testing in the third year. In that year he naturally has more plants at his disposal and he can further make his choice. Then comes the stage in which he can test his material on a small scale on other types of soil and thus he can find out more about the properties of his seedlings year after year.

The first person in Holland to conceive the idea of breeding seedlings from such varietal crossings was Geert Veenhuizen, a gardener from the province of Groningen, who commenced his crossing work in 1889 and continued it for many years. He introduced some 80 of these seedlings as varieties, of which the Eigenheimer is the most important; he also bred Rode Star, Thorbecke and Ideaal. Veenhuizen's idea was soon followed, particularly by Klaas de Vries, a school teacher from Suameer (Friesland) who bred the world-famous variety Bintje from a cross between the old varieties Munstersen and Fransen.

The more other breeders began to engage in this work, the more the need was felt for an impartial body which could compare all the newly bred varieties with each other. Thus after some developments the present situation came into being, in which breeders can send tubers of their most promising seedlings to the Government Institute for Research on Varieties of Field Crops. This institute then carries out preliminary field trials on the new varieties and selects the best of them for further testing on a extensive scale and on all types of soil.

On the basis of the results of all these trials two or three new varieties are annually included in the List of Varieties, which means that it is permitted freely to market plant material from these varieties. The breeder of the new variety receives remuneration when it is included in the List of Varieties and also receives a sum every year in proportion to the amount of seed potatoes submitted for inspection to the General Netherlands Inspection Service for Seeds of Field Crops and for Seed Potatoes (N.A.K.).

By this arrangement the breeders' work is rewarded, and as a result the zest for this work has increased to such an extent that at present 180 breeders are engaged in it on a greater or smaller scale.

Naturally it is becoming more and more difficult for the breeder to win a place for his seedlings on the List of Varieties. The breeders must

produce more and more seedlings to find one exceptionally good one. The present situation is that on an average one out of 50—100,000 seedlings is ultimately placed on the List.

Up to 1942 new varieties in Holland were solely obtained by crossing varieties. However, during the war, and particularly thereafter, a completely new method developed.

The nature of this work can best be illustrated by an outline of the first breeding project of this kind that has been carried out, *viz.* the breeding of varieties of potatoes which are completely immune from *Phytophthora infestans.*

It had not been possible to breed such varieties by varietal crossing, Bintje and Eigenheimer, which are highly susceptible to *Phytophthora.* especially substitutes for the early or medium early varieties, Eersteling, To achieve this purpose all the same, use has been made of the wild Mexican species *Solanum demissum.* This species occurs in a large diversity of forms as a weed in potato fields and many of its genotypes are not attacked by *Phytophthora.*

Crossings of *Sol. demissum* with varieties of potatoes easily succeed, but unfortunately the hybrids are completely useless as potatoes, although they are immune from *Phytophthora.* If these hybrids are again crossed with varieties of potatoes, however, seedlings are obtained which display an immense abundance of types and among which—though rarely—plants occur which already give evidence of many good properties, combined with immunity.

If we again cross these plants with varieties of potatoes, we once more obtain very variable seedlings, but with a higher percentage of valuable plants. If necessary we once again cross a plant in this way, and then it is certain that we will encounter good future varieties among the hybrids.

In a similar way varieties of potatoes can also be obtained which are resistant to the dreaded nematode *Heterodera rostochiensis,* which causes potato sickness. This is effected by means of resistant varieties of the South American cultivated species *Solanum andigenum.* Varieties which are not attacked by the Colorado beetle can be obtained by using the resistant wild species *Solanum chacoense* from Uruguay, and such which are not damaged by night frost by crossing with the wild species *Solacaule,* which occurs at great heights in the Andes and which can itself endure a temperature of —8° C.

Instead of on intervarietal crosses, this work is based on a series of successive backcrossings. In each stage of this breeding work the seedlings have to possess in the first place the special characteristics (*Phytophthora* resistance *etc.*) for which the scheme is set up and, in addition, one has to select for all other favorable properties as promptly as possible. In most cases this implies testing by means of laboratory methods.

Needless to say, this work requires special knowledge in the field of genetics and special skill in the determination of the resistance. Therefore the projects can only be carried out by large bodies such as the Institute of Agricultural Plant Breeding in conjunction with the Foundation for Agricultural Plant Breeding, and by a few other breeding stations.

The above-mentioned combination of Institute and Foundation also sets itself the task of making it possible for the breeders, who are insufficiently equipped, to participate in this work. For that purpose parental material is bred from which promising seedlings can be obtained by crossing with various varieties.

On behalf of the private breeders such hybrid seed is produced on a large scale by these two bodies (about 1,000,000 seeds *per annum*). For that purpose the potatoes are grafted on tomatoes, because in that case no tubers are formed and all the energy of the plant is used to form flowers and fruits.

Since it is difficult for many of the breeders to raise their plants from seed, the Foundation for Plant Breeding grows about 130.000 seedlings *per annum* in glasshouses in pots of 8—10 cm diameter. One tuber each is kept from about 80,000 of these seedlings and this plant material is available to any breeder for a small sum.

There is a very great demand for these seeds and tubers, and it is therefore possible to let the many private breeders participate in this new breeding work, and in this way to have cultivated each year the large numbers of seedlings required for the selection of a few good varieties.

Since most of these breeders have, through years of experience, developed considerable skill in selection work, it is certain that the maximum is got out of the cultivated material.

The work on *Phytophthora* has now reached a stage at which the decision regarding inclusion in the List of Varieties can be taken with regard to the older seedlings within a few years.

Breeding for resistance to potato sickness is still in its initial stages, but many breeders are participating in it and future varieties can be expected among the seedlings raised this year. The parental material resistant to the Colorado beetle and to frost is still being built up; the resistant material available must still be crossed to arrive at seedlings from which varieties can be selected.

An interesting aspect of this new work, which is of great importance, is the discovery that these seedlings derived from crosses with wild species include some which possess a greater yielding capacity than has been found up to now with the progeny of intervarietal crossings.

—Reprinted by permission from The Windmill, No. 14, September, 1954.

MOISTURE METERS AID IRRIGATION

Many vegetable farmers needlessly waste time and money irrigating because of improper timing, says Prof. A. J. Pratt of the vegetable crops department at Cornell University.

Recent Cornell research shows that "when" crops are irrigated is as important as "whether" they are irrigated; and that when to irrigate can quite accurately be determined by an electrical gadget called a "moisture meter."

Work conducted by George Bradley, assistant, indicates that irrigation when about half the soil moisture is used up gives much larger yields than does an emergency, save-the-crop type of application.

Professor Pratt says it is important to apply irrigation water long before the moisture level in the soil drops to the wilting point. Because of delayed applications, much irrigation water is applied too late to help vegetable yields.

To determine the all-important moisture content of the soil, he advises the consideration of any one of the three moisture meters now on the market.

These meters measure the flow of electrical current through plaster of paris blocks buried in the soil. The resistance of the blocks to the flow of current is regulated by the moisture content of the soil around the blocks.

One or two of the blocks, with wires leading to the surface, are buried in the crop row in each acre at planting time. Later in the season, the farmer can determine if the moisture content has fallen below the 50 per cent level by clipping the portable meter on the lead wires from the various blocks.

Pratt recommends that blocks be placed at six, twelve, and possibly eighteen inch levels. In this way, it is possible to roughly determine how much water is left in the soil; and after irrigation how deep the water has penetrated. It probably isn't necessary to wet below the top foot for most vegetables in New York.

The specialist feels that any farmer with thousands of dollars invested in irrigation equipment cannot afford to be without one of these meters which range in price from $40 to $80.

Although Cornell tests have been limited to potatoes, onions, sweet corn, lima beans, peas, spinach, and tomatoes, Pratt says there is no reason why the meter should not prove useful with all vegetable crops.

From the New York State Colleges of Agriculture and Home Economics, M. C. Bond, Dir. of Exten.

BAG MANUFACTURER PUBLICIZES POTATOES

Coincidental with the announcement of the National Potato Council's proposed publicity program comes news of an additional campaign by a potato bag manufacturer. Union Bag and Paper Corporation reports that it has already started nationwide consumer publicity to help increase potato consumption.

Harry M. Recher, Union's Director of Flexible Packaging Sales, advises that this campaign will emphasize the nutritive and economic value of potatoes and disprove the popular conception that they are

fattening. In addition, stories will feature recipes for varied, tasty potato dishes. "We believe that the potato industry's plan to increase potato consumption through publicity is very sound and sure to bring results. Union's own publicity efforts will give added emphasis to this industry campaign."

In addition to reaching daily and weekly newspapers and general magazines, Union's potato publicity stories will go to some 3,000 company publications. These company house organs are beamed to a very desirable and hard-to-reach audience," Mr. Recher said. "And because they are intimately read they offer a wonderful medium for our stories."

NEW BOOKS

Two new books have recently come to our attention that we think many of our readers would be interested in reading.

The **Care and Feeding of Garden Plants** came off the press in January and is the first of its kind. It describes plant nutrition and feeding for home and commercial gardeners. It contains numerous full color illustrations which show gardeners how to recognize hunger signs in their house and garden plants and the text tells how to correct the troubles.

This book describes nutritional deficiency symptoms of lawns, trees, shrubs, fruits and vegetables. It contains chapters on how plants grow, how to grow a good lawn, shrubs and trees for the home ground, house plants, fertilizer recommendations for garden flowers and vegetable gardens and suggests varieties best adapted to various areas.

It also contains large lists of references to other publications on the various subjects discussed.

This book is written by 14 outstanding authorities and should prove valuable to home owners in both the country and suburban areas.

It is published by the American Society for Horticultural Science and The National Fertilizer Association. Copies are available at bookstores or from the National Fertilizer Association, 616 Investment Building, Washington 5, D. C.

Color in Foods contains the proceedings of a symposium sponsored by the Quartermaster Food and Container Institute for the Armed Forces, U. S. Army Quartermaster Corps, Chicago, Ill.

The book covers four areas of research on color in foods as follows:

1. Color and its Relationship to Food Investigations
2. Color Measurement in Relation to Commodities and Consumer Interest
3. Instruments for the Study of Color
4. Measurements of Color and Color Differences in Relation to Quality

There are 3 to 5 papers under each subject. This symposium should be of interest to all research and regulatory personnel concerned with color in foods.

Copies are available without cost at the Quartermaster Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Illinois.

FOR SALE

Volume 1, Nos. 1 and 2 @ 75¢; Nos. 3, 5, 13, 14 @ $1.25.

We have no complete sets of the American Potato Journal but we have a limited supply of the following issues at the prices listed.

Volume 2, Nos. 6 and 11 @ 75¢; Nos. 3, 4, 8 and 9 @ $1.25.

Volume 3, Nos. 3, 4, 7, 9, 10, 11 and 12 @ $1.25.

Volume 4, Nos. 2, 6, 8, 11 and 12 @ 75¢, others @ $1.25.

Volume 5, Nos. 1 and 8 @ 75¢; Nos. 4, 9, 10, 12 @ $1.25.

Volume 6, Nos. 4, 6 and 10 @ $1.25; others, 75¢.

Volume 7, Nos. 2, 4, 8 and 9 @ $1.25.

Volume 8, Nos. 1, 3, 8, 9 and 11 @ 75¢; Nos. 10 and 12, $1.25.

Volume 9, All Nos. @ 75¢; complete volume $8.00.

Volume 10, No. 4 @ $1.25; 2, 8 and 12 not available; others @ 50¢.

Volume 11, No. 2 @ $1.25; others @ 50¢; complete volume $5.00.

Volume 12, No. 2 @ $1.25; others @ 50¢; complete volume $5.00.

Volume 13, No. 1 @ 75¢; others @ 50¢; complete volume $5.00.

Volume 14, No. 1 @ 75¢; others @ 50¢; complete volume $5.00.

Volumes 15-27, All Nos. 30¢, except Vol. 17, No. 3; Vol. 20, No. 2; Vol. 23, Nos. 1 and 3, and Vol. 26, No. 2 @ $1.25; complete volumes $3.50.

Volumes 28-31, All Nos. @ 35¢; complete volumes $4.00.

Proceedings of Annual Meetings

Proceedings of the first 18 annual meetings of the Potato Association of America with the exception of the 5th, 6th and 7th meetings were published and are available at $2.00 each. We have no copies of the second proceedings and a limited supply of the others.

These proceedings contain all of the papers that were presented at the various annual meetings some of which are of great interest.

An Index of the 26 volumes of the American Potato Journal is still available at $3.00 a copy.

All of the above items may be secured from John C. Campbell, Treasurer, Potato Association of America, Rutgers University, New Brunswick, New Jersey.

LOOK HOW MUCH it pays to package in film made of BAKELITE Polyethylene

Data supplied by **The Dobeckmun Co.**, Cleveland, Ohio

"Potato Sales Went Up 32%"

That's the experience of but one of many big supermarkets . . . after merchandising potatoes packaged in durable film made of BAKELITE Polyethylene.

A very important point for growers and shippers to remember is that packaging in polyethylene bags drastically cuts waste at the retail level. Premium prices at the grower level are better protected.

A second and just as important advantage is the ability to create brand identity at the grower level. It has been well indicated that retailers, even though they do their own pre-packaging today, would prefer to buy potatoes already packaged in polyethylene (and obviously at a higher unit price than growers receive for bulk shipments).

Throughout the country, there are suppliers of potato packaging bags made of film produced from BAKELITE Polyethylene. See your own local supplier and get the facts. And remember, when you specify film made of BAKELITE Polyethylene, you know the resins used were of uniform high quality assured by Bakelite Company, largest producer of polyethylene.

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Many potato soils are deficient or critically low in magnesium, a plant food which is essential to the profitable production of big yields of top grade potatoes. You can correct this deficiency and get better yields, finer quality by using *Sul-Po-Mag* in mixed fertilizers.

What is *Sul-Po-Mag? Sul-Po-Mag* is a properly balanced combination of sulfate of potash and sulfate of magnesium, both water-soluble and immediately available to the growing crop. Sulfate of potash for potatoes of higher specific gravity. Sulfate of magnesium for larger yields of no. 1 grades.

Check up on your soil needs. If your soil is deficient in magnesium and potash, use *Sul-Po-Mag*. Many leading fertilizer manufacturers are regularly using *Sul-Po-Mag* in their potato grades. See your dealer and insist on a fertilizer containing soluble sulfate of magnesium and sulfate of potash from *Sul-Po-Mag;* it will pay you well.

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